Abstract

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Export Performance and Trade Facilitation Reform: Hard and Soft Infrastructure

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1. Introduction

In an international trade environment of declining tariffs, trade facilitation—broadly defined as the set of policies aiming at reducing export and import costs—has been in the spotlight policy fora as the next key option to reduce trade costs in developing countries. The relationship between export performance and trade facilitation is complex, not only because a country's trade flows may change through its own trade facilitation reforms and through its trading partners' reforms, but also because of the multi-dimensionality of trade facilitation.

In a narrow sense, trade facilitation is associated with the reduction of on-the-border transaction costs other than tariff cuts, which essentially involves the simplification and standardization of customs formalities and administrative procedures related to international trade. The current WTO negotiations on trade facilitation are mainly linked to this dimension of border (or customs) facilitation. In a broader sense, trade facilitation not only includes at-the-border issues, but also beyond-the-border issues, dealing for instance with the business environment, the quality of infrastructure, transparency, and domestic regulations. All of these factors have an impact on export performance through the cost channel. Trade facilitation measures can be undertaken along two dimensions: a "hard" dimension related to tangible infrastructure such as roads, ports, highways, telecommunications, as well as a "soft" dimension related to transparency, customs management, the business environment, and other institutional aspects that are intangible.

A myriad of indicators related to different aspects of trade facilitation at the country level and with extensive geographic coverage have recently been collected by different organizations, and used in empirical research to estimate their impact on trade.[2] From an econometric point of view, including variables related to trade facilitation, measuring similar aspects on the right-hand side of a model, such as a gravity specification, can be conducive to multicolinearity. A way of circumventing multicolinearity is to reduce the dimension of the data by aggregating highly correlated indicators into a single indicator.

[2] See, for instance, Wilson et al. (2003, 2005), Francois and Manchin (2007), and Iwanow and Kirkpatrick (2008).

One of the contributions of this paper is the construction of four new aggregate indicators related to trade facilitation from a wide range of primary indicators using factor analysis, a statistical modeling technique that explains the correlation among a set of observed variables through an unobserved "common factor." To our knowledge, factor analysis has not yet been used to derive trade-related indicators. It not only helps to circumvent multicolinearity by reducing the dimensions of the data, it is a less arbitrary and more rigorous procedure for deriving an "aggregate" indicator compared with averaging out primary indicators. Moreover, unlike principal component analysis, it assumes an underlying analytical model of causality assuming that unobserved variables (to be estimated by the procedure) –our indicators— cause observed variables –the primary indicators—and, thus, provides a more rigorous framework. The new aggregate indicators contain the information of a wider range of individual indicators than any previous study.

Two of the four indicators are more related to the "hard" dimension of trade facilitation: i) physical infrastructure and ii) information and communications technology (ICT). The other two indicators are more closely linked to the "soft" dimension: iii) border and transport efficiency and iv) the business and regulatory environment. The indicators are derived for 101 countries over the period 2004-07, a greater coverage than previous indicators and a more recent one. The indicators are derived from a pool of 20 primary indicators collected from different sources: Doing Business (DB), World Development Indicators (WDI), World Economic Forum (WEF), and Transparency Internatio

the impact of trade facilitation on the extensive and intensive margins.[3] In order to implement the Heckman procedure on our sample, an identifica

primary factors driving intra-African trade expansion. Using a computable general equilibrium model, Abe and Wilson (2008) explore institutional trade facilitation indicators and find that reducing corruption and improving transparency in APEC countries to the average level of the region would increase trade in the region by 11 percent and global welfare would expand by $406 billion. Using detailed data on transit, documentation, and ports and customs delays on Africa's exports collected by Doing Business at the World Bank, Freund and Rocha (2010) find that that transit delays have the most economically and statically significant effect on African exports. They find that a one-day reduction in inland travel times leads to a 7 percent increase in exports.

Iwanow and Kirkpatrick (2008) construct aggregated indicators of trade facilitation (in the on-the-border sense), and infrastructure for 2003 and 2004, by applying simple average to primary indicators mainly collected from Doing Business and the World Development Indicators. They estimate a standard gravity model augmented with these indicators and find a positive impact of the three indicators on exports. As their paper focuses on Africa, they interact their indicators with an

delayed prior to being shipped reduces trade by at least 1 percent. Nordas, Pinali, and Geloso Grosso (2006) analyze the relation between time for import and export procedures, logistics services, and international trade, and find that time delays result in lower trade volumes and can reduce the probability that firms will enter export markets for time-sensitive products. Clark, Dollar, and Micco (2004) explain va

$$X_1 \quad \zeta_1 F \quad e_1$$
$$X_2 \quad \zeta_2 F \quad e_2$$
$$\ldots\ldots\ldots\ldots\ldots\ldots$$
$$X_m \quad \zeta_m F \quad e_m$$

where ζ_k is the loading factor associated with the observed variable X_k. The procedure allows estimation of the factor loadings as well as estimates of the unobserved factor F per sub-group, the latter being retained as the synthetic indicator. Loading factors provide information on the weights and correlation between each variable and the common factor; the higher the load, the more relevant is the primary variable in defining the dimensionality of a factor.[7]

We perform the factor analysis procedure in two stages: as a preliminary stage, a diagnostic factor analysis procedure contributes to define the sub-group of variables to be considered for each indicator. Second, we re-run the procedure on the sub-groups to estimate the common factor to be taken as the indicator.

In the first stage, the diagnostic factor analysis procedure is performed on two separate groups of primary variables; the first group consists of variables related to hard infrastructure, and the second one puts together variables related to soft infrastructure or institutional aspects. Again, the idea of this stage is to run a diagnosis as to identify sub-groups or primary variables within hard-infrastructure indicators and within soft-infrastructure indicators that would have higher correlations. Table A1 in the Appendix shows the loading factors of the diagnostic procedure as well as other statistics, The loading factors estimated in the explanatory analysis show a clear regrouping of the primary variables of hard infrastructure into two sub-groups that we call physical infrastructure and information and communications technology (ICT) because of the variables considered in each of them. Similarly, two sub-groups emerge clearly among the soft infrastructure variables, and we call them border and transport efficiency and business and regulatory environment.

In the second stage, we re-run the factor analysis procedure on each of the four identified sub-groups in order to prevent the noise caused by adding variables that are unimportant.[11] In other words, we run four separate factor analysis procedures on each sub-group, with a single estimated factor retained by the data[12], which will be considered as our indicator.

The four indicators derived from the four sub-groups of primary variables along the "soft" and "hard" dimensions of infrastructure are:

HARD INFRASTRUCTURE:

[11] Indeed, if we stop at the first-stage and derive two indicators from two factors in each group, when the two indicators are constructed from the two factors in each group, the country rankings of such indicators change dramatically and implausiblyy. due to the noise added by variables unimportant to each sub-group.

[2] The data imposes one single factor in each procedure of the second stage, according to an iterative standard procedure (see for instance Rayment and Joreskog (1996)

1. *Physical infrastructure* measures the level of development and quality of ports, airports, roads, and rail infrastructure.

2. *Information and communications technology (ICT)* is interpreted as the extent to which an economy uses information and communications technology to improve efficiency, and productivity as well as to reduce transaction costs. It contains indicators on the availability, use, absorption, and government prioritization of ICT.

SOFT INFRASTRUCTURE:

3. *Border and transport efficiency* aims at quantifying the level of efficiency of customs and domestic transport that is reflected in the time, cost, and number of documents necessary for export and import procedures.

4. *Business and regulatory environment* measures the level of development of regulations and transparency. It is built on indicators of irregular payments, favoritism, government transparency, and measures to combat corruption.

Table 1 here. Loading Factors, TF indicators

Table 1 reports the final loading factors associated to each primary variable, as well as the percentage of variance explained by each identified factor. In all cases, the first retained factor captures a large amount of the variation, which ranges from 77 percent in the case of border and transport efficiency, to 88 percent in the case of the business environment.[13]

Table 2 here. Summary Statistics for Values of Trade Facilitation Factors and Primary Indicators

We provide some statistics of the derived indicators across regions and years. For simplicity, the synthetic indicators are also scaled on a range of 0 to 1. Table 2 reports summary statistics on the derived indicators and the underlying primary indicators, as well as the country with the highest and lowest scores throughout the panel. Figure 1 shows the average value of

[13] Although in some cases, the factors associated to the different observed primary variables are similar --as in the group of the Business Environment indicator--, the ranking of countries according to the indicators is different than the ranking of countries according to an indicator that is a simple average of primary variables.

stage sample selection model to take into account zero or missing bilateral trade flows.[15] The two-stage procedure aims at correcting the standard selection bias that can result from the necessity to drop observations with zero trade.

More precisely, we estimate the following specification as the outcome equation in terms of our sample selection model:

$$\ln X_{ijt} = \beta_0 + \beta_1 \ln(\text{Border\_Transport\_Effic}_{it}) + \beta_2 \ln(\text{Business\_ Environment}_{it}) + \beta_3 \ln(ICT_{it}) + \beta_4 \ln(\text{Infrastructure}_{it}) + \beta_1 \ln 1 + t_{ijt} + \beta_2 \ln(GDP_{it}) + \beta_3 \ln(Population_{it}) + \beta_4 \ln Distance_{ij} + \beta_5 RTA_{ijt} + \beta_6 Landlocked_i + \beta_7 \text{Border}_{ij} + \beta_8 \text{Common\_Language}_{ij} + \beta_9 \text{Colonial\_Relationship}_{ij} + \beta_{10} \text{Common\_Colonizer}_{ij} + \gamma_t I_j + \varepsilon_{ijt}$$

where:

- X_{ijt} is country i exports to country j in year t.
- $\text{Border\_Transp\_Effic}_{it\,it}$ is the indicator for trading across the border of country i in year t. The higher the value, the more efficient the country is in trading across borders.
- $\text{Business\_ Environment}_{it}$ is the business environment indicator of country i in year t; the higher the value of the factor, the more business friendly the environment and regulations of the country.
- ICT_{it} represents the information and communications technology level that country i has and uses to improve efficiency and economic activity in year t.
- $\text{Infrastructure}_{it}$ represents the quality level of infrastructure in country i in year t; the higher the value of the factor, the better the physical infrastructure of the country is.
- $t_{ijt,}$ is the total average tariffs for imports of country j from country i in year t.
- GDP_{it} is gross domestic product of country i in year t.
- $Population_{it}$ is population of country i in year t.

[15] The first stage consists of a probit regression that explains the probability that country i exports to country j (selection equation), where the dependent variable is a dummy that is equal to one if country i exports to country j. The second stage consists of a gravity equation estimated in logarithmic form that explains the volume of exports

- $Distance_{ij}$ is the distance between the capitals of countries i and j.
- RTA_{ijt} is a dummy variable that is equal to 1 when countries i and j have an active preferential trade agreement in year t.
- $Landlocked_i$ is 1 when country i is landlocked.
- $Border_{ij}$ is 1 when countries i and j have a common border.
- $Common\_Language_{ij}$ is 1 when countries i and j have the same language.
- $Colonial\_Relationship_{ij}$ is 1 when countries i and j have the same colonizers.
- $Common\_Colonizer_{ij}$ is 1 when countries i and j have the same colonizers post-1945.
- I_j and l_t are two vectors with importer-specific and year-specific dummies.
- $_{ijt}$ is a random error term satisfying the usual assumptions.

Regarding the selection estimation, we assume that X_{ijt} is observed when the following condition is met:

Envi t) ln( )
ln(Infrastructure) ln 1 ln( ) ln( ) ln tan
Border Common_Language Colonial_Relationship .
Common_Colonizer 0

Francois and Manchin (2007) and Iwanow and Kirkpatrick (2008) use a similar estimation strategy to estimate the impact of infrastructure and institutions on trade.[16] We include fixed effects for both, importers and years. A complete specification would also require fixed effects for exporters to control for multilateral resistance terms (MRTs),[17] but their inclusion can wipe out the effect of exporter-specific variables that do not vary substantially throughout the four-year panel, such as the trade facilitation indicators for exporters.[18]

Baier and Bergstrand (2009) introduce a method for "approximating" price index multilateral resistance terms using a first-order Taylor expansion, yielding a log-linear expression for multilateral resistance terms (MRTs) that is a function of exogenous variables. It can be included in the estimation equation to be estimated with a simple OLS method. The approach has the advantage of producing tractable comparative statistics that underline the role of country size in MRTs, as trade barriers have a large impact on the terms of small countries, which typically trade a large proportion of their output internationally. While estimating the impact of a country's trade logistics system on its exports, Behar, Manners, and Nelson (2009) proxy MRTs using Baier and Bergstrand's method in a two-stage selection model of gravity akin to Helpman, Melitz, and Rubinstein (2008).

In this research, we follow a procedure similar to Baier and Bergstrand (2009) and Behar, Manners, and Nelson (2009) in our estimates to correct bilateral trade cost variables to consider

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[16] Francois and Manchin (2007) do not satisfy the exclusion restriction in their Heckman estimates. Iwanow and Kirkpatrick (2008) use an alternative variable of common religion as suggested by Helpman et al. (2008). However, a religion variable does not have the temporal variation necessary for our sample.

[17] Anderson and van Wincoop (henceforth AvW) (2003) solve the so-called border puzzle–the implausibly large negative effect of the U.S.-Canada border on trade between Canadian provinces and U.S. states highlighted by McCallum (1995) — by showing that general equilibrium e

MRT. In a nutshell, implementing the procedure consists of replacing bilateral variables that account for theoretical bilateral trade costs in the specification and vary across exporter-importer pairs, namely: tij, $Dis\tan ce_{ij}$, RTA_{ij} $_{ij}$

Table 3 reports estimates for the two-stage Heckman selection model defined by expressions (1) and (2). Columns 1a and 1b report the estimated coefficients of the outcome and the selection equations, respectively. In the outcome equation, the coefficients of all four trade facilitation indicators are positive and significant. As trade facilitation indicators are scaled on a zero-one interval, the magnitude of estimated coefficients can be informative of the relative impact of these aspects on trade. The coefficient of physical infrastructure is, indeed, the largest of all four. Business environment seems to be the next important factor for exporters, followed by ICT and border and transport efficiency. All other coefficients are significant and have the expected signs. Indeed, higher tariffs, longer distance between partners discourage trade, as well as being landlocked. By contrast, the trade volume is higher between partners in a regional trade agreement, as well as between richer and more populous countries. Contiguous partners, countries having a common official language, and countries having had a common colonizer or a colonial relationship are also likely to trade more intensively. The selection equation estimates (column 1b) provide a hint on the impact of each determinant on the probability of exporting, the so-called extensive margin. Most coefficients are significant and have the same sign as in the outcome equations. Only the coefficient of business environment has a negative sign, although it is non-significant. The coefficient of the entry-cost variable appearing in the first stage is negative and significant, as countries with higher entry barriers are less likely to trade.[19]

Table 3 here: Baseline Estimates

As explained above, including exporter-specific dummies wipes out the effect of trade facilitation variable, as the latter do not vary considerably on time and can be subsumed in the fixed effects, as reported in table A3 of the Appendix. As an additional check to compare the explanatory power of our trade facilitation variables with respect to other regressors in the model, we perform a two-step procedure. In the first step, we estimate our baseline model replacing our exporter specific variables with exporter dummies. In the second step, we regress a

[19] A similar exercise was carried out excluding the tariff variable lead(ab)-4ilar ((((00030 0 0 1(ayi.385 -1.725 TD.0002 Tc-.0013-98

variable ‘y’ containing the estimates of exporter-dummy coefficients, which can be interpreted as the volume of trade predicted by exporter dummies, on exporter’s trade facilitation indicators and other variables of the model. For each regressor in the second step, we estimate the squared partial correlation (a measure of total variance of ‘y’ explained by the regressor and not associated to other variables) and the squared semipartial correlation (the reduction in the R-squared when the regressor is removed from the regression). The estimates are further explained and reported in Appendix B. Overall, the trade facilitation indicators, notably physical infrastructure, have a greater contribution to the total variance of ‘y’ in comparison to other variables, such as tariffs, distance, or colonial dummies.

Columns 2a and 2b report estimates of a specification that replaces the continuous variable in the selection equation with a dummy that equals 1 if country i’s exports to country j were positive in the previous year (t-1). The rationale is that countries having positive export flows in the preceding year are more likely to export during the current year. The estimates do not change substantially.

We replace variables that vary across exporter-importer pairs with MRT-corrected expressions in order to better account for multilateral resistance. The estimates reported in Column 3a and 3b do not vary greatly. Whereas the coefficients of infrastructure, business environment and border and transport efficiency are larger than baseline estimates, ICT coefficient becomes implausibly negative. Yet, infrastructure and business environment remain the indicators with the greatest impact on exports. Compared with the MRT-corrected specification, the baseline specification (1a and 1b) leads to slightly smaller effh t.5sof3D.0005 Tc-.0021sT8J20

these lines is less clear for the other two institutional variables, as the coefficients of the interaction terms ar

performance of a country along the trade facilitation dimension. Indeed, the ranking of countries according to the estimated residuals diverges substantially from the ranking of countries along the original indicators, making policy inferences difficult. Therefore, these estimates are just illustrative and are reported for completeness.

Table 5 here: Robustness checks

Second, column 2 reports estimates when TF indicators are instrumented by their 3-year lagged value to reduce the bias that may arise from potential reverse causality. As the panel has observations for four years, the sample is reduced to a cross section when using the 3-year lag indicators. The coefficients for physical infrastructure, business environment, and ICT are similar to the baseline estimates, whereas the coefficient for border and transport efficiency is greater, which may be due to the fact that the latter variable evolves more over time than the other three indicators.

Third, we follow Freund and Rocha (2010) and examine the effect of trade facilitation on trade in new products[22]. The intuition is that trade in goods having not been exported in the past cannot have had an impact on the historical development of either hard infrastructure or in institutions. Column 3 reports estimates of the model when exports are restricted to new goods. The coefficients of the four indicators are positive and significant, with similar magnitude. The effect of physical infrastructure is smaller than the baseline estimates. On one hand, it can be interpreted as evidence that endogeneity tended to overstate the effect of physical infrastructure on exports. On the other hand, it can only be interpreted as proof that physical infrastructure has a greater impact on exports of new products (extensive margin), than in existing products (intensive margin), the latter just being a small share of total exports. It is also consistent with the previous finding that physical infrastructure has a smaller effect for richer countries, who tended to export more new products during this period[23].

[22] We define new products as goods that were not exported in the period 1999-2002 and that entered into the export market in the interval 2003-2006.

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The total number of kilometers of roads, often divided by either the area of the country or the population, and the percentage of paved roads in a country are frequently taken as measures of hard infrastructure. (See, for instance, Francois and Manchin (2007) and Iwanow and Kirkpatrick (2008).) Yet, these indicators may not be fully comparable across countries, as they do not take into account other country-specific dimensions, such as population density, the location of cities, or the concentration of economic activity. For completeness, we apply factor analysis to construct a modified indicator of physical infrastructure, which in addition to the original primary indicators includes the percentage of paved roads and the total kilometers of roads divided by the population and the area of a country. Column 4 presents estimates of the

countries with lower income tend to export those commodities and ICT tends to have a lower marginal impact the lower the income of a country.

Table 6 here: Estimates on different samples.

5. Potential Benefits from Trade Facilitation: Counterfactual Estimates

Based on our baseline estimates, we simulate the effects of improving each aspect of trade facilitation on the export performance of the developing countries in the sample.[24] As the model contains tariffs, the coefficient estimates are used to compute counterfactual ad-valorem variations that would otherwise be generated by a benchmark variation of our composite indicators. The benchmark retained in this exercise is an improvement of each exporter's indicators halfway to the level of the top performing country in the region along each indicator. To illustrate how these counterfactuals are estimated, suppose that regulatory reform or investment in the ICT sector of an exporter country leads to a 1 percent increase in the ICT indicator. This leads to a change in trade flows of about $\hat{E}_{ICT}$ percent according to the gravity estimates.[25] The same change in trade flows would be brought about if all importers were to cut the tariffs applied to imports from the country by an equivalent value $\hat{E}_{ICT} / \hat{E}_{Tariffs}$. Therefore, the latter ratio roughly represents the "ad-valorem tariff-cut equivalent" or "ad-valorem equivalent" of a 1 percent change in the cost of export procedures inferred from gravity model estimates.

We simulate the effects of improving each aspect of trade facilitation on trade. We took into consideration the disparities among countries by performing regional simulations using the best performing country in each index as the benchmark. Counterfactual estimates are reported in Figure 4. As expected, countries with lower values of trade facilitation indicators would experience higher export growth after the improvement along their trade facilitation indicators.

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[24] For simplicity, we use coefficient estimates of the outcome equation (second-stage) and disregard the marginal effects of the indicators on the selection equation (first stage) that feed in the second stage through marginal changes in the inverse Mills ratio.

[25] For notation purposes, let $\hat{E}_X$ be the estimated elasticity of imports with respect to the variable X entering in the gravity equation. In the case of Doing Business export costs, the estimates should be negative.

To illustrate the analysis, we briefly discuss the simulation results for selected countries with the lowest performance in each region.

Figure 4. Simulation Results: Exports growth an ad-valorem equivalent of an increase in each indicator half-the-way to level of the exporter

In all regions, with the exception of South Asia, investment in physical infrastructure quality halfway to the top performer will result in the greatest trade gains. In addition, it is worth mentioning the importance of regional characteristics for policy decision making. For instance, improvements in infrastructure in Sub-Saharan African countries would generate an important increase in trade flows, whereas for some South Asian countries, investment in improving the business environment would generate the greatest return. In most regions, improved border and transport efficiency to the benchmark is associated with lower exports growth as the estimated elasticity of this indicator on exports is the lowest among four indicators. Furthermore, countries of these regions are not so heterogeneous along this indicator.

East Asia and Pacific

If investment in Mongolia were to improve the quality of infrastructure halfway to the level of Malaysia, the country with the best infrastructure in East Asia, then exports of the former would increase by 58.9 percent. In other words, the increase in trade in Mongolia due to this improvement of infrastructure would be equivalent to a 40.3 percent reduction in the value of current tariffs on goods from Mongolia. If investment were focused on the improvement of information and communications technology or border and transport efficiency halfway to the level of the best performer, Mongolia's exports would increase by only 7.4 and 3.0 percent, respectively.

The improvement of business environment in Mongolia appears to be the second best alternative after infrastructure. Investment to improve the business environment half the way to the level of Malaysia would increase exports by 12.7 percent; in other words, this improvement in exports would be equivalent to a reduction of 8.7 percent in current import tariffs.

Europe and Central Asia

Levels of development in trade facilitation vary widely across countries in this region. In the case of infrastructure, Bosnia and Herzegovina, the country with the lowest level of infrastructure quality, would experience an important increase in exports (53 percent) by improving its infrastructure to half the level of Lithuania. This increase in exports would also be feasible if Bosnia and Herzegovina reduced its current import tariffs by 36.3 percent.

In this region, improvements in border and transport efficiency also have a high rate of return. For instance, if investment in Kazakhstan were to improve its border and transport efficiency halfway to the level of Romania, Kazakhstan would increase its exports by 23.2 percent. This increase in exports is equivalent to a reduction of 15.8 percent in import tariffs.

Middle East and North Africa

The picture for countries in the Middle East and North Africa reveals significant gains in trade due to an increase in investment in infrastructure and ICT. Considering the lowest ranked country, Algeria, an increase in the level of infrastructure to half the level of Tunisia would yield an increase of 18.8 percent in the volume of exports. For instance, if investment in Algeria were to improve the quality of ICT halfway to level of Tunisia, exports would increase by 6.6 percent; this would be equivalent to a reduction of 4.5 percent in import tariffs.

Latin America and the Caribbean

In Latin America, Bolivia appears to be the country that would benefit the most from an improvement in infrastructure quality. If Bolivia were to improve to half the level of Chile, exports would increase by 49.1 percent. The same increase in exports would also be possible if Bolivia reduced its import tariffs by 33.6 percent.

The results also show that improvement in the business environment, the second best alternative in the region, is very important for Venezuela. This country would increase exports by 26.5 percent if investment were to improve in this area to half the level of Chile, the best performer of the region. A reduction of 18.1 percent in the current ad-valorem tariffs would be necessary to obtain the same level of improvement in exports.

South Asia

Different from the other regions, South Asia appears to receive better returns to investment in the business environment. The results show that Bangladesh, the country with the lowest value for the business environment index, would experience the highest export growth after improvement in this indicator halfway to that of India. The increase in trade (38.4 percent) due to improvement in the business environment would be equivalent to a 26.3 percent reduction in the value of current tariffs on goods from Bangladesh.

If Bangladesh were to improve its level of infrastructure quality to half the level of India, exports would increase by 17.6 percent. This increase in exports would be equivalent to a reduction of 12.1 percent in the value of import tariffs.

Sub-Saharan Africa

Countries in the Sub-Saharan Africa region also experience a dramatic increase in exports. For instance, if investment were focused to improve the infrastructure quality of Chad halfway to the level of South Africa, trade levels of the former would increase by 79.3 percent. This increase in exports would also be feasible with a reduction of 57.7 percent in import tariffs.

If Chad were to invest in improving the business environment, exports would increase by 22.6 percent. If Cameroon were to invest in the business environment to improve the indicator to half the level of South Africa, exports would increase by 16.8 percent.

6. Conclusions

Overall, the results show that improvement in infrastructure quality would bring the greatest benefits in terms of export growth. The analysis of the effects of these factors on trade flows provides useful information to guide policymakers on which might be the area or areas in which resource allocation would bring the greatest benefits. Among our four indicators, physical infrastructure has the greatest impact on exports in almost all specifications, and samples. Furthermore, we found evidence that the impact of physical infrastructure is decreasing with the

income level, whereas the opposite occurs with ICT, for which the richer the country, the greater its marginal impact on export performance.

Illustrative estimates show that improvements in infrastructure and border and transport efficiency halfway to the level of the regional top performer can be substantial. However, the high cost of investment in physical infrastructure is a factor to be considered. Of course, investment in physical infrastructure can also have large spillovers that should be taken into account in the cost-benefit analysis, but they are difficult to measure.

The net balance of costs and benefits cannot yet be stated with certainty for a given country. Such an assessment can only be made within the framework of specific infrastructure project appraisals, and it can only be addressed on a case-by-case basis. However, improvement in other areas, such as border and transport efficiency, where costs are considerably lower in comparison with investment in physical infrastructure, shows promising results for developing countries. Although general estimates on the yield of thes

country. In addition, our results have only addressed the static impacts of trade facilitation reform, without assessing directly their impact on growth, productivity, and overall development as such. Yet, empirical evidence suggests that there are good reasons to believe that better trade facilitation can impact each of these positively.

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Revisiting Trade Facilitation Indicators and Export Performance.

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TABLES AND FIGURES

Table 1. Loading Factors, Trade Facilitation Indicators

1a. Information and communications technology

Cumulative variance

Factor	Variance	Proportion
ICT	3.41	0.85

Rotated factor loadings

Variable	Factor1	Uniqueness
Availability of latest ICT technology	0.96	0.08
Level of technology absorption	0.93	0.13
Extent of business internet use	0.93	0.14
Government prioritization of ICT	0.87	0.24

Source: Authors' calculations.

1b. Physical infrastructure

Cumulative variance

Factor	Variance	Proportion
Infrastructure	3.30	0.83

Rotated factor loadings

Variable	Factor1	Uniqueness
Quality of ports infrastructure	0.94	0.11
Quality of airports infrastructure	0.92	0.16
Quality of roads infrastructure	0.94	0.11
Quality of railroad infrastructure	0.82	0.32

Source: Authors' calculations.

1c. Business environment

Cumulative variance

Factor	Variance	Proportion
Business environment	5.30	0.88

Rotated factor loadings

Variable	Factor1	Uniqueness
Government transparency	0.96	0.09
Public trust for government	0.92	0.16
Irreg. payments in exports and imports	0.92	0.15

Table 2. Summary Statistics for Values of Trade Facilitation Factors and Primary Indicators

Indices/variables	Mean	SD	Lowest performance		Highest performance		Source
Information and Communications Tech.							
Indicator	**0.49**	**0.24**	**Zimbabwe**	**0.01**	**Sweden**	**1**	
Availability of latest ICT technology	0.62	0.19	Moldova	0.27	Sweden	1	WEF
Level of technology absorption	0.73	0.13	Bolivia	0.41	Iceland	1	WEF
Extent of business internet use	0.62	0.17	Algeria	0.32	Rep. of Korea	1	WEF
Government prioritization of ICT	0.68	0.14	Zimbabwe	0.33	Singapore	1	WEF
			Bosnia &				
Infrastructure Indicator	**0.49**	**0.24**	**Herzegovina**	**0.05**	**Singapore**	**1**	
Quality of ports infrastructure	0.56	0.21	Armenia	0.17	Singapore	1	WEF
Quality of airports infrastructure	0.67	0.16	Paraguay	0.27	Singapore	1	WEF
Quality of roads infrastructure	0.57	0.21	Mongolia	0.23	France	1	WEF
Quality of railroad infrastructure	0.46	0.23	Paraguay	0.15	Switzerland	1	WEF
Border and Transport Efficiency Indicator	**0.69**	**0.19**	**Kazakhstan**	**0.02**	**France**	**1**	
Number of documents to export	0.50	0.16	Kyrgyzstan	0.15	France	1	DB
Number of days to export	0.25	0.16	Kazakhstan	0.06	Estonia	1	DB
Number of documents to import	0.49	0.17	Azerbaijan	0.14	France	1	DB
Number of days to import	0.						

Table 3. Baseline Estimates

1(a)	1(b)	2(a)	2(b)	3(a)	3(b)	4(a)	4(b)
						INTERACTIONS WITH	
Baseline		Alternative		MRT-correction[a]			

Table 4. Estimation with Different Methods

	1(a)	1(b)	2	3	4	5
	Baseline Outcome	Baseline Selection	OLS	Tobit	Et -Tobit	Poisson
Ln(Border_Transport_Effic_i)	0.071	0.265	0.046	0.546	0.162	0.104
	[0.041]*	[0.025]***	[0.041]	[0.059]***	[0.026]***	[0.076]
Ln(Business_ Environment_i)	0.147	-0.047	0.153	-0.046	0.128	0.198
	[0.030]***	[0.030]	[0.030]***	[0.056]	[0.024]***	[0.068]***
Ln(ICT_i)	0.118	0.066	0.079	0.421	0.081	0.197
	[0.036]***	[0.028]**	[0.035]**	[0.059]***	[0.026]***	[0.083]**

Table 5. Robustness Checks

	1	2	3	4	5	6
	Residuals (outcome)	3 Year Lag (outcome)	New Goods (outcome)	Infr+WDI (outcome)	Average 2004 -07[1] (outcome)	Sum[2] (outcome)
$Ln(Border\_Transp\_Effic\_i)_{(resid)}$	-0.108					
	[0.071]					
$Ln(Business\_ Env\_i)_{(resid)}$	0.234					
	[0.035]***					

Ln(GDP_i)	1.195	0.928	0.726	0.887	1.029	
	[0.009]***	[0.028]***	[0.0138]***	[0.016]***	[0.026]***	
Ln(Population_i)	-0.023	0.225	0.0714	0.244	0.215	
	[0.010]**	[0.029]***	[0.0136]***	[0.016]***	[0.027]***	
Landlocked_i	-0.095	-0.205	-0.309	-0.129	-0.295	
	[0.036]***	[0.068]***	[0.0338]***	[0.036]***	[0.065]***	
Ln(Distance_ij)	-1.049	-0.981	-0.857	-0.967	-1.097	-1.311
	[0.018]***	[0.036]***	[0.0176]***	[0.019]***	[0.035]***	[0.019]***
RTA_{ij}	0.508	0.538	0.298	0.482	0.328	0.428
	[0.037]***	[0.076]***	[0.0355]***	[0.038]***	[0.073]***	[0.037]***
Border	1.109	1.319	0.166	1.213	1.128	0.611
	[0.068]***	[0.138]***	[0.0824]**	[0.070]***	[0.150]***	[0.075]***
Common_Language	0.423	0.663	-0.00835	0.557	0.855	0.787
	[0.038]***	[0.077]***	[0.0350]	[0.041]***	[0.072]***	[0.038]***
Colonial_Relationship	0.526	0.34	0.0658	0.378	0.191	0.704
	[0.056]***	[0.116]***	[0.0705]	[0.057]***	[0.119]	[0.061]***
Common_Colonizer	0.958	0.85	0.655	0.948	0.93	1.09
	[0.059]***	[0.118]***	[0.0524]***	[0.059]***	[0.112]***	[0.055]***
Constant	-7.796	-5.593	-5.399	-0.55	-4.789	27.996
	[0.471]***	[0.675]***	[0.287]***	[0.389]	[0.564]***	[0.260]***
Observations	40400	10004	40400	40400	10100	40400

All regressions include time and importer fixed effects. Robust standard erro

Figure 1. Average Value of Trade Facilitation Indicators by Region

Source: Authors' estimates.

Figure 2. Temporal Evolution of Indicators (Base=1 in 2004)

Source: Authors' estimates.

Figure 3. Marginal Impact of the Indicators as a Function of Per Capita GDP

Figure 4. Simulation Results

4a. East Asia and Pacific.

Source:

4c. Middle East and North Africa

Sources

4d. Latin America and the Caribbean

Source:

4e. South Asia

4f. Sub-Saharan Africa

Source

Appendix A. Additional Tables and Graphs

Table A1. Loading Factors in Exploratory Factor Analysis

a. Hard infrastructure

Factors	Variance	Difference	Proportion	Cumulative
Factor1	2.10	0.	0.	
Factor2	2.1	0.	0.2	
Factor3	0.67	0.64	0.11	1.03
Factor4	0.03	.	0.00	1.03

	Factor Loadings		
Variable	**Factor 1**	**Factor 2**	**Uniqueness**
Availability of latest ICT technology	**0.75**	0.57	0.06
Level of technology absorption	**0.72**	0.50	0.17
Extent of business internet use	**0.73**	0.43	0.15
Government prioritization of ICT	**0.68**	0.42	0.34
Quality of ports infrastructure	0.47	**0.75**	0.15
Quality of airports infrastructure	0.56	**0.72**	0.16
Quality of roads infrastructure	0.44	**0.76**	0.15
Quality of railroad infrastructure	0.39	**0.50**	0.36

b. Soft infrastructure or institutional variables

Factors	Variance	Difference	Proportion	Cumulative
Factor1	2.20	0.	0.	
Factor2	1.3	0.31	0.	
Factor3	0.95	0.65	0.10	0.98
Factor4	0.30	0.28	0.04	1.03
Factor5	0.03	.	0.00	1.03

Variable	Factor Loadings		Uniqueness
	Factor 1	**Factor 2**	
Government transparency	**0.83**	-0.35	0.08
Public trust for government	**0.91**	-0.22	0.10

Belgium	0.67	Tunisia	0.65	Tunisia	0.62	Bahrain	0.83
Brazil	0.66	South Africa	0.65	United States	0.61	Lithuania	0.83
Qatar	0.65	Chile	0.65	Malaysia	0.61	Italy	0.82
Tunisia	0.65	Namibia	0.63	Estonia	0.60	Latvia	0.82
Luxembourg	0.64	Estonia	0.60	Spain	0.58	Serbia and Montenegro	0.82
Czech Republic	0.62	Greece	0.60	Jordan	0.54	Mauritius	0.82
Portugal	0.62	Panama	0.60	Bahrain	0.53	Mexico	0.82
Spain	0.60	Bahrain	0.60	South Africa	0.52	Poland	0.81
Italy	0.58	Lithuania	0.58	Botswana	0.51	Dominican Republic	0.80

Bolivia	0.25	Moldova	0.22	Argentina	0.20	Ecuador	0.53
Bulgaria	0.24	Mozambique	0.21	Guyana	0.20	Namibia	0.52
Mongolia	0.23	Madagascar	0.20	Kenya	0.18	Paraguay	0.50
Bosnia and Herzegovina	0.23	Uganda	0.20	Nigeria	0.17	Ethiopia	0.49
Zambia	0.22	Serbia and Montenegro	0.18	Ecuador	0.17	Nigeria	0.49
Cameroon	0.20	Malawi	0.17	Zimbabwe	0.17	Russian Federation	0.44
Ethiopia	0.20	Benin	0.17	Paraguay	0.17	Zambia	0.42
Moldova	0.19	Mongolia	0.16	Benin	0.16	Venezuela	0.40
Malawi	0.19	Paraguay	0.16	Uganda	0.15	Zimbabwe	0.39
Guyana	0.17	Albania	0.15	Cameroon	0.13	Cambodia	0.37
Paraguay	0.16	Kyrgyz Republic	0.15				

Constant	-3.506	-3.085	-1.369	-4.126	54.66	-47.89
	[0.303]***	[0.329]***	[0.313]***	[0.319]***	[21.64]**	[16.03]***
Observations	40400	40400	40400	40400	40400	40400

All regressions include time and importer fixed effects. Robust standard errors are in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Source: Authors' calculations based on data from COMTRADE for trade flows; TRAINS for tariffs; and WDI, WEF, and Doing Business for trade facilitation factors.

ssions on New Goods

New goods: MRT-correction[a]		New goods: INTERACTIONS WITH GDPpc	
Outcome	Selection	Outcome	Selection
0.196	0.271	0.414	-1.031
[0.0396]***	[0.0229]***	[0.293]	[0.203]***
0.255	0.00657	0.0567	-0.432
[0.0306]***	[0.0269]	[0.140]	[0.160]***
-0.139	-0.0235	-0.618	0.179
[0.0372]***	[0.0252]	[0.173]***	
0.320	0.268	3.806	0.481
[0.0459]***			

Source: Authors' calculations based on data from COMTRADE for trade flows; TRAINS for tariffs; and WDI, WEF, and Doing Business for trade facilitation factors.

Appendix B.

the proportion of the variance of y that is explained by each predictor. Indeed, the squared partial correlation is a measure of total variance of ‘y’ explained by the regressor and not associated to other variables, whereas the squared semipartial correlation can be interpreted as the reduction in the R-squared when the regressor is removed from the regression. All the TF indicators are significant at the conventional significance level. Overall, the trade facilitation indicators, notably physical infrastructure, have a greater contribution to the total variance, compared to other variables, such as tariffs, distance, or colonial dummies. The infrastructure variable has the highest value Squared SCC, explaining 5.7% of the variance, followed by the ICT indicator that adds 3.6 % to the explained variance.